STAFF SUMMARY SHEET

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Clearance for Material for Public Release	USAFA-DF-PA- 154	20130226

13012 McHarg

SUMMARY

1. PURPOSE. To provide security and policy review on the document at Tab 1 prior to release to the public.

2. BACKGROUND.
Authors: Cadet Heather Nelson, Dr. Michael Dearborn, Dr. Matthew McHarg

Title: FalconSAT-7: A Solar Imaging CubeSat

Document type: Article

Description: Submission to the Space Weather Journal

Release Information: Space Weather

Previous Clearance information: None

Recommended Distribution Statement: Distribution A, Approved for public release, distribution unlimited.

Add to paper

3. DISCUSSION. This research is funded by DARPA but conducted at USAFA. USAFA public release is required.

4. VIEWS OF OTHERS. None

5. RECOMMENDATION. Sign coord block above indicating document is suitable for public release. Suitability is based solely on the document being unclassified, not jeopardizing DoD interests, and accurately portraying official policy.

// signed //

CORY T. LANE, Maj, USAF
Director of Research
Department of Physics

Tabs
1. Article for Space Weather Journal

FalconSAT-7: A Solar Imaging CubeSat

Heather C. Nelson, Michael E. Dearborn, and Matthew G. McHarg, United States Air Force Academy

The FalconSAT-7 (FS-7) program is run by the Space Physics and Atmospheric Research Center in the Department of Physics at the United States Air Force Academy . FS-7 is a 3U CubeSat that houses a solar telescope payload called Peregrine, which will deploy a lightweight and flexible, polyimide membrane from a canister to form a 20 centimeter telescope optimized for the H-alpha wavelength (656.3 nanometer). To accomplish this objective, the polyimide membrane is patterned with 2.5 billion holes of varying size that act like a Fresnel Zone Plate to image sunspots and other solar features. One of the great benefits of the FS-7 program is the very low size, weight, and power (SWAP) of both the spacecraft and Peregrine payload. The FS-7 Peregrine payload SWAP is 1.5U (10x10x15 centimeter), 1.7kilograms, and 5 watts power. The size and weight of FS-7 itself is very minimal compared to the size and weight of the recent science payload on Solar Dynamics Observatory which is 300 kilograms and has a primary optic of 14 centimeter. Like FS-7, the Solar Dynamics Observatory also examines the photosphere but more specifically looks at the wavelength of nickel at 676.8 nanometer with approximately 1.2 arcsec angular resolution.

H-alpha is a particularly interesting wavelength of photospheric light in the study of space weather. It is known that the Sun's chromosphere plays a substantial role in the understanding of solar events such as solar flares and coronal mass ejections which can affect satellites in orbit and systems on the surface of the Earth. The chromosphere is an irregular and hard-to-understand layer of the Sun's atmosphere. However, it is currently believed that magnetic tubes in the photosphere influence solar events higher in the atmosphere. However, the photospheric tubes and the filamentary plasma in coronal loops are smaller than 0.1 arcsec when

observed at 1AU, which is smaller than any current space or ground based solar telescope is able to resolve.

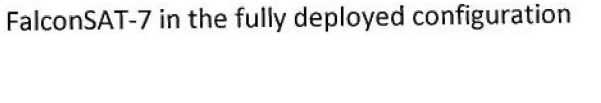
The 20 centimeter telescope onboard FS-7 provides an angular resolution of 0.8 arcsec compared to the 1.2 arcsec for the Solar Dynamics Observatory (a 50% improvement in resolution). The Solar Optical Telescope (the largest solar telescope currently on orbit with a primary optic diameter of 50 centimeter) has an angular resolution of 0.25 arcsec. However, future generations of the Peregrine payload, when scaled up and flown on a small satellite (e.g. 180 kilograms, one meter cube volume, and one meter photon sieve telescope) would provide the best resolution images ever taken of the Sun (on the order of sub 0.1 arcsec resolution) which would be a 150% improvement in resolution over the Solar Optical Telescope.

Some ground-based solar telescopes, such as Big Bear which has a theoretical angular resolution of 0.09 arcsec, have the potential to be high enough resolution for quality solar imaging; however, they suffer from atmospheric distortion, typically resulting in resolutions greater than 1 arcsec. Therefore, a space-based telescope is preferable to a ground-based system because space-based telescopes do not image through the Earth's atmosphere.

The major stakeholders for the FS-7 program include the United States Air Force Academy, the Air Force Institute of Technology, MMA Design LLC, NASA/Goddard, Air Force Research Laboratories, the Air Force Space Test Program, and DARPA. The United States Air Force Academy developed the photon sieve and optical and camera subsystems. The Air Force Institute of Technology is integrating the payload to the spacecraft bus. MMA Design LLC. is designing and building the deployment system. NASA/Goddard did initial research and testing into the feasibility of using photon sieve technology in solar imaging. The Air Force Research Laboratory is conducting membrane distortion analysis. The Air Force Space Test Program

provided the funding for the Zero-G test flight and will provide launch and integration services. DARPA is the primary funding source for the program.

FalconSAT-7 in the fully deployed configuration



An optical simulation created at the Air Force Academy showing diffraction limited image of sunspots in center of Peregrine field of view